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A newly discovered Irish eclipse prediction of AD 754: the earliest in the Latin West – Immo Warntjes

This is just a brief note to announce a discovery recently made in the Bibliothèque nationale de France. On a research trip to Paris last year, Jacopo Bisagni (NUI, Galway) intensively studied numerous computistical manuscripts, principally for their potential relevance for the transmission of Irish textual materials through Brittany. One of these (Paris BnF Lat. 6400B; Fleury, saec. X¹) showed an exceptionally high degree of Irish features. Bisagni consulted me about the content of the computistical section, and it transpired that it contains a hitherto unknown text (fols 274r–284r), the discovery of which will shortly be announced elsewhere. This text in turn incorporates a short tract on eclipse prediction (fol. 277r–v).

Tackling the vexed question of eclipse prediction, i.e. the mathematical modeling of their recurrence, is generally considered to be an achievement of the so-called Carolingian Renaissance. Since the AD 760s, the occurrences of lunar and solar eclipses, among other celestial phenomena, were recorded in what Arno Borst termed the *Karolingischer Reichskalender*.² Charlemagne himself showed a keen interest in observable astronomy and its implications on earthly matters. In AD 798, the planet Mars, named after the Roman God of war, appeared in the sky while the not-yet emperor was campaigning against the rebellious Saxons. He sent letters to Alcuin, his political advisor and head of the palace school in Aachen, inquiring about the reasons for Mars's appearance and whether this would influence the outcome of his campaign.³ Even more irritating was the news the now emperor received from a Byzantine embassy in AD 811. According to his Byzantine informants, two solar eclipses had occurred in the previous year, of which only one had been visible in Francia. With Alcuin dead, Charlemagne turned to the Irish scholar Dungal for explanation; he used Pliny to demonstrate that a recurrence of this phenomenon after 177 days is, in fact, possible.⁴

* I thank David Juste, Leofranc Holford-Strevens, Philipp Nothaft, and Jacopo Bisagni for stimulating discussion of the issues outlined in the present note.

¹ Marco Mostert, *The library of Fleury: a provisional list of manuscripts* (Hilversum 1989), 211. The manuscript is readily available at the *Gallica* website.

² Arno Borst, *Die karolingische Kalenderreform* (Hannover 1998), 284, 288; idem, *Der karolingische Reichskalender und seine Überlieferung bis ins 12. Jh.*, 3 vols (Hannover 2001), 1196, 1198, 1245, 1342–3. This list was then extended in the *Encyclopedia of AD 809* in its redaction of 812: *Lib. comp.* V 10, ed. by Arno Borst, *Schriften zur Komputistik im Frankenreich von 721 bis 818*, 3 vols (Hannover 2006), 1277–9; for commentary, see Lothar Boschen, *Die Annales Prumienses: ihre nähere und ihre weitere Verwandtschaft* (Düsseldorf 1972), 21–2; for the scientific context, David Juste, 'Neither observation nor astronomical tables: an alternative way of computing planetary longitudes in the Early Western Middle Ages', in Charles Burnett, Kim Plofker, and Michio Yano, *Studies in the history of the exact sciences in honour of David Pingree* (Leiden 2004), 181–222: 185–7.

³ Only Alcuin's responses have survived; they are ed. by Ernst Dümmler in MGH Epistolae 4, 241–5, 249–53 (no. 149, 155). For discussion, see Dietrich Lohrmann, 'Alcuins Korrespondenz mit Karl dem Großen über Kalender und Astronomie', in Paul L. Butzer & Dietrich Lohrmann, *Science in Western and Eastern Civilization in Carolingian times* (Basel 1993), 79–114: 93–6; Kerstin Springsfeld, *Alkuins Einfluß auf die Komputistik zur Zeit Karls des Großen* (Stuttgart 2002), 49–55, 269–78, 298–9.

⁴ Again, only Dungal's response survives; it is ed. by Ernst Dümmler in MGH Epistolae 4, 570–80. For discussion, see the excellent studies by Bruce S. Eastwood, 'The astronomy of Macrobius in Carolingian Europe: Dungal's letter of 811 to Charles the Great', *Early Medieval Europe* 3 (1994), 117–34, repr. in idem, *The revival of planetary astronomy in Carolingian and post-Carolingian Europe* (Aldershot 2002), article V; idem, *Ordering the*

The discourse also took place in a more anonymous environment. In a short tract entitled *Solis eclipsis quemadmodum innotescat*, it is argued that solar eclipses will recur after 24 years, lunar eclipses 177 days after a solar eclipse.⁵ Both arguments are obviously nonsense, and it is difficult to establish where the author acquired his data. As David Juste pointed out to me, the same information can be found in the mysterious *Liber Nemroth*, and he considers *Solis eclipsis quemadmodum innotescat* a summary of the relevant chapters (29–30 and 40) of that book.⁶ Both the *Liber Nemroth* and *Solis eclipsis quemadmodum innotescat* refer to the solar eclipse of AD 807.⁷ Juste has proven the *Liber Nemroth*, in the Latin version in which it survives, to have been composed before the end of the ninth century,⁸ and on the basis of the eclipse reference Haskins suggested a date of composition of around AD 807.⁹ Likewise, the *Solis eclipsis quemadmodum innotescat* must have been composed after the AD 807 and presumably before the AD 810 eclipse, because otherwise this would have provided a more recent point of reference (though the author could obviously have worked later from written

heavens: *Roman astronomy and cosmology in the Carolingian Renaissance* (Leiden 2007), 43–63, 175–7.

⁵ *Solis eclipsis quemadmodum innotescat* is ed. as *Lib. comp.* V15a in Borst, *Schriften*, 1297. See also Juste, ‘Neither observation’, 195.

⁶ The best manuscript witness of the *Liber Nemroth* is Paris BnF Lat. 14754, with chapters 29–30 and 40 on fols 209r–v and 212v respectively; this codex is readily available online at the *Gallica* website.

⁷ *Solis eclipsis quemadmodum innotescat* (= *Lib. comp.* V15a; Borst, *Schriften*, 1297): *Deliquium solis contigisse fertur anno ab incarnatione Domini octingentesimo septimo*. The relevant passage in the *Liber Nemroth* (c. 30), where the year in question is given in *anni mundi* (see n 8), is printed in Charles H. Haskins, ‘Nimrod the astronomer’, in idem, *Studies in the history of mediaeval science* (Cambridge 1924), 336–45: 344–5: *Si vis scire in quo anno fit eclipsis, sume annos ab origine mundi, scito quot sunt, et subtrahe ex ipsis vi cc xc viiii, et quot remanent divide eos per decem et novem, et sicut scriptum est in rota ita invenies eclipsis solis in tempore ipsius*. Haskins worked from Vatican BAV Pal. lat. 1417 and Venice BNM lat. VIII 22; AM 6299 is in the Vatican codex only, while the Venice MS as well as Paris BnF Lat. 14754 unknown to Haskins have AM 6298. See the comment on the date in David Juste, ‘On the date of the “Liber Nemroth”’, *Journal of the Warburg and Courtauld Institutes* 67 (2004), 255–8: 255–6 n 4. In Frankish sources, the solar eclipse of 11 February 807 is well recorded: *Lib. comp.* V 10 (Borst, *Schriften*, 1279); *Annales regni Francorum s.a.* 807 (MGH SS rer. Germ. 6, 122). Note that this eclipse was principally visible in the northern parts of Ireland and Britain (<http://eclipse.gsfc.nasa.gov/SEsearch/SEsearchmap.php?Ecl=08070211>).

⁸ Juste, ‘On the date’; the literature on the *Liber Nemroth* is there conveniently listed in n 1.

⁹ Haskins, ‘Nimrod the astronomer’, 344–5, was undecided whether AM 6299 (or rather the 6298 of the better manuscript witnesses) reflected the Byzantine or the Antiochian era, leading to AD 791 and 807 respectively. At least Frankish sources (assuming that the redactor of the *Liber Nemroth* worked in Francia) do not record a solar eclipse for AD 791, pointing to the era of Antioch and AD 807 as correct. In fact, the argument should rather be made the other way round: As David Juste informed me, there are many indications in the *Liber Nemroth* of Syrian chronology, not least the beginning of the year on 1 October; therefore, the era applied was that of Antioch, referring to the solar eclipse of AD 807; this was principally visible in the northern parts of Britain and Ireland (see n 6), suggesting it more likely that the author of the Latin version of the *Liber Nemroth* worked in Francia or further north than in the Mediterranean.

documents referring to the 807 but no later eclipse).¹⁰ Accordingly, at the end of Charlemagne's reign, there was a noticeable interest in the prediction of eclipses among some Carolingian intellectuals (and the emperor himself). This circle, however, should not be overrated. The *Liber Nemroth* survives in only three manuscripts, and these date from the 12th century and later.¹¹ *Solis eclipsis quemadmodum innotescat*, on the other hand, is extant in many more codices, with only two from the ninth century though.¹² In Carolingian times, despite the emperor's interest, the complex question of how to predict eclipses did not enter the mainstream, it remained the domain of only very few specialists. Now, the eclipse prediction tract in the Paris MS is older than this. To be sure, eclipses had been recorded in the Insular world before Carolingian times.¹³ The most famous, no doubt, is the solar eclipse of 1 May AD 664, which may have been one of the reasons for the Synod of Whitby. It is noted in the Irish annals and by Bede, who (or his source) infamously changed the date to 3 May to accommodate the Dionysiac lunar calendar.¹⁴ And this eclipse of AD 664 also forms the basis of the newly discovered text, though neither Julian calendar date nor incarnation year are given. It is described thus:

Annus uero naturalis finitur, quando aeclepsis solis euenit. Quando in his temporibus? Aeclepsis stat ante pestilentiam magnam, nam in illa hora nona tenebrosa uissa est.

Comparison with the Irish annals corroborates through parallels in wording that the same event is referred to:

Annals of Ulster s.a. 664:¹⁵ *Te[ne]brae in kl. Maii in nona hora, et in eadem aestate coelum ardere uisum est. Mortalitas in Hiberniam peruenit in kl. Augusti.*

Annals of Tigernach s.a. [AU 663]:¹⁶ *Tenebre i callaind Mai in hora nona, et in eadem estate celum ardere uisum est. Mortalitas magna in Hiberniam peruenit hi calaínd Auguist.*

Accordingly, it appears that the author of the new tract worked from Irish annalistic records, and this, among many other features in the bigger computus incorporating this text,¹⁷

¹⁰ All Frankish sources mentioned in n 6 record the solar eclipse of 30 November 810, and it also provided the background to Charlemagne's inquiry to Dungal (see n 4); for its visibility, see <http://eclipse.gsfc.nasa.gov/SEsearch/SEsearchmap.php?Ecl=08101130>.

¹¹ For the manuscript transmission of this text, see Juste, 'On the date', 255 n 3 and notes 6 and 7 above.

¹² Borst, *Schriften*, 1297 edited this text from three manuscripts (Melk SB 412; Vatican BAV Reg. lat. 309; Vatican BAV Vat. lat. 643); Juste, 'Neither observation', 191–5 adds a fourth, Vatican BAV Reg. lat. 596; in private communication, he kindly provided me with a list of seven other witnesses: Bern BB 250; Paris, Bibl. de l'Arsenal, 1128; Paris BnF lat. 7418; Paris BnF lat. 12117; Vatican BAV Reg. lat. 1263; Vatican BAV Urb. lat. 102; Venice, Biblioteca Nazionale Marciana, fondo antico 344. Only two of these, in total, 11 codices are from the Carolingian period (Melk SB 412; Vatican BAV Reg. lat. 309).

¹³ See especially Daniel P. Mc Carthy & Aidan Breen, 'Astronomical observations in the Irish annals and their motivation', *Peritia* 11 (1998), 1–43.

¹⁴ Bede, *Historia ecclesiastica* III 27, ed. by Charles Plummer, *Venerabilis Baedae opera historica*, 2 vols (Oxford 1896), i 191: *Eodem autem anno dominicae incarnationis DCLXIII^o, facta erat eclipsis solis die tertio mensis Maii, hora circiter X^a diei; quo etiam anno subita pestilentiae lues, depopulatis prius australibus Britanniae plagis, Nordanhymbrorum quoque prouinciam corripiciens, atque acerba clade diutius longe lateque desaeuiens, magnam hominum multitudinem strauit.* For Bede's redating, see Jennifer Moreton, 'Doubts about the calendar: Bede and the eclipse of 664', *Isis* 89 (1998), 50–65.

¹⁵ Seán Mac Airt & Gearóid Mac Niocaill, *The Annals of Ulster (to A.D. 1131)* (Dublin 1983), 134.

¹⁶ Whitley Stokes, *The Annals of Tigernach*, 2 vols (Felinfach 1993), i 158.

identifies the author as Irish. To be sure, the information of a pre-10th century (the date of the MS) solar eclipse occurring at the time of a major plague only matches the one of AD 664. And this was visible in totality only in northern Ireland and Britain and in parts of the Continent which had not yet received Christianity and with this the written word, independently confirming the Insular origin of the tract discussed here.¹⁷

The author is then precise about his time of writing, 3x30=90 years after the eclipse of the great plague:

Cur ab illo tempore non vissa est, dum ab eo tempore ter XXX anni sunt usque ad presens tempus?

This leads to a date of composition of AD 664+90=754. The quote also transmits the author's frustration. In his theory, a solar eclipse was supposed to occur every 30 years, and since three times this period had passed from the last recorded eclipse, he had high expectations for another to be visible in his present year. His hopes were shattered, leaving him with the difficult task of defending a theory that did not produce the expected results. The anonymous certainly was not short of explanations: 1) the eclipse may only have occurred in the southern hemisphere and was therefore not visible in the northern half of the globe; 2) the weather may simply have been too bad, the eclipse may have been obscured by clouds; 3) the eclipse may only have been partial and therefore not necessarily discernable. Certainly, he remained convinced of the correctness of his assumptions.

How, then, did the author arrive at the 30-year period between eclipses which is the key element of his theory? This the text does not explain, but it can be reconstructed from our knowledge of the eighth-century Irish computistical milieu the author apparently worked in. There are, in fact, two different levels, a literary and an empirical one, which must have convinced the anonymous of the correctness of his assumption.

Turning to the literary evidence first: As with so many of the seventh- and eighth-century Irish theories, the starting point here is Isidore. The bishop of Seville had defined the *annus naturalis* as the period between two solar eclipses and the *annus magnus* as the period necessary for all moveable celestial bodies to return to the exact same place in the zodiac.¹⁹ Isidore provided no numerical value for the crucial *annus naturalis*; but he assigned 19 years to the *annus magnus*, conflicting with his own evidence, as some of the orbital period of some planets was longer than that. Consequently, Irish computists looked for alternatives. The Munich Computus, an Irish text composed in AD 718/9, specified the *annus magnus* as consisting of 30 years; rather than calculating the least common multiple of the periods of revolution of all moveable celestial bodies, the Munich Computist simply took the longest individual period, that of Saturn, as the numerical value for the *annus magnus*.²⁰ The last step was to project this length of the *annus magnus* on the *annus naturalis*. It is a fortunate

¹⁷ See the following note by Bisagni; the article on the entire computus will contain an exhaustive study of all Irish features.

¹⁸ For the path of the solar eclipse of 1 May AD 664 see the map at: <http://eclipse.gsfc.nasa.gov/SEsearch/SEsearchmap.php?Ecl=06640501>, based on calculations by Fred Espenak.

¹⁹ Isidore, *De natura rerum* VI 3, ed. by Jacques Fontaine, *Isidore de Seville: Traité de la nature* (Bordeaux 1960), 193, 195: *Annus naturalis est cum se soli luna supponit, ut inter orbem solis et oculos nostros media facta tenebras totius orbis efficiat, quod dicitur eclipsis. Cuius ratio diutius obscura fuit, sed a Milesio quodam philosopho exposita est. Annus magnus dicitur quando omnia sidera, certis temporibus numerisque conpletis, ad suum locum uel ordinem reuertuntur. Quem annum antiqui undeicensimo anno finire uel adinpleri dixerunt.*

²⁰ Munich Computus 31, ed. by Immo Warntjes, *The Munich Computus: text and translation. Irish computistics between Isidore of Seville and the Venerable Bede* (Stuttgart 2010), 92–3.

coincidence that this key shift is transmitted in another of the Paris manuscripts with Irish and Breton connections analysed by Bisagni, Lat. 7418A (fol. 23v):

Annus naturalis unde incipit et ubi desinit vel in quo tempore finitur et quis illum reperit et quot temporis spatium habet et cur naturalis dicitur? Ab VIII Kl Iulii incipit et in hoc tempore iterum desinit et talem hunc annum milesius reperit et XXX annis cursum suum implet. Et quid huius anni ciclus probet nisi eclipsin solis, nam XXXo anno eclipsis perficitur.

Working from literary models like this, the author of the eclipse prediction in Lat. 6400B believed that the *annus naturalis*, the period from one solar eclipse to another, consisted of 30 years:

Annus naturalis est: ab VIII Kl incipit, et in hoc tempore iterum finitur, et talem mileseus hinc annum reperit, et XXX annis cursum suum implet. Et quid huius anni cyclus probet? Id est aeclipsis solis, XXXmo anno aeclipsis perficitur.

The only difference between these two Paris texts is that the passage in Lat. 7418A starts the *annus naturalis* with Isidore's 24 June (*VIII Kl Iulii*), while the eclipse prediction of AD 754 drops the *Iulii*, leaving the date vague.

The empirical level is even more intriguing: Besides the solar eclipse of AD 664, the anonymous surely had one other datum available. Working in a monastic context, the author viewed science through a Christian lens. Also, the boundaries between exegesis and computus were rather fluid, with eighth-century intellectuals certainly being expected to have profound knowledge in both. The Synoptic Gospels are quite explicit that a solar eclipse occurred at the time of Christ's crucifixion.²¹ Luke 3:23 argues that Christ was baptised at the age of 30, while John's long chronology of Christ's ministry indicated that he died and resurrected in the fourth year after baptism.²² Accordingly, it could be argued that a solar eclipse had occurred in the 34th years from Christ's birth, in AD 34. This provided the anonymous with two dates, a solar eclipse in AD 34 and another in AD 664, with a difference of 630=21x30 years between them. The 30-year period between eclipses was thus empirically proven, especially since both the Synoptic Gospels and the Irish annalistic record unanimously noted the ninth hour as the time of occurrence of the respective eclipses.

There was, however, one major flaw with this theory: The sources available to the anonymous provided three conflicting Julian calendar dates. According to the passage in Lat. 7418A, the *annus naturalis*, the period from one solar eclipse to another, started on 24 June (it is 23 June in the following passage), the date of the summer solstice; according to the Irish annals, the eclipse of AD 664 had occurred on 1 May; and according to patristic tradition, the eclipse at Christ's crucifixion had happened on 25 March.²³ Since, in the anonymous's theory, eclipses recurred after exactly 30 years, they always had to fall on the exact same Julian calendar date. The anonymous acknowledges this contradiction at the very end of his tract:

Hoc prediximus, quod in VIII Kl Iulii hic cyclus naturalis anni incipit et finis XXX annis in eundem circulum reddit. Nobis contradicit hora nona tenebrosa ante pestilentiam uissam, nam in VIII Kl Aprilis illa hora nona taenebrosa uissa est et autumnii temporum haec aeclipsis solis uissa est.

Still, this did not lead the anonymous to discard his theory altogether.

This newly discovered text provides us with a wonderful and very rare insight into the early medieval scientific mind. It also changes our perception of the development of science in this

²¹ Matthew 27:45; Mark 15:33; Luke 23:44–5. Note that, as Leofranc Holfrord-Strevens pointed out to me, this contradicts the other chronological detail presented in the Gospels, that Christ died around the time of the full moon, as solar eclipses could only occur at new moon; how medieval scholars squared that problem, is not transmitted.

²² See C. Philipp E. Nothaft, *Dating the passion: the life of Jesus and the emergence of scientific chronology (200–1600)* (Leiden 2011), 22–3.

²³ See Nothaft, *Dating*, 19–102.

period. When Frankish schools, at least in terms of scientific thought, were still in their infancy, the most challenging questions were already tackled in other parts of the Latin West: The Carolingian Renaissance did not much improve on what had already been established in the preceding century. Full-scale studies of both this eclipse prediction treatise and the Computus incorporating it will appear in due course.